**Open nuclear systems in structure and astrophysics**

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The John D. Fox Laboratory at Florida State University operates a 9 MV Tandem + 8 MV superconducting linear accelerator system, which is used for research in nuclear structure, reactions and nuclear astrophysics by the group of six local scientists, their students and and a growing number of outside collaborators. The laboratory houses a lineup of updated experimental devices, including the most recently installed 16-Clover Clarion-2 [1] array for high-resolution gamma spectroscopy, which was built and is operated at FSU in collaboration with Oak Ridge National Laboratory. The second prominent device is a large-acceptance high-resolution magnetic spectrograph called SE-SPS for which two ancillary devices were developed, the SABRE [2] silicon detector array for resonance spectroscopy and the CeBrA scintillator array [3] for coincident reaction-gamma spectroscopy. Finally, the Resolut in-flight radioactive beam facility is used to provide beams one- or two nucleons off stability for research in nuclear astrophysics and nuclear structure of exotic nuclei[4], with the Anasen[5] and Encore[6] active-target detectors.

A research focus on the physics of unbound nuclear states has developed at the laboratory, carried out in experiments with the magnetic spectrograph and the radioactive beam facility. A prominent example lies the confirmation and characterization of a proton-resonance in $^{11}$B. The existence of this resonance had been proposed as a doorway to explain the observation of a beta-delayed proton-decay in the neutron-rich nucleus $^{11}$Be[7,8]. In experiments at the FSU radioactive beam facility this resonance was populated with the proton-transfer reaction $^{10}$Be(d,n)$^{11}$B and its surprisingly strong single-proton character was established [9]. This is understood as a consequence of the interactions with the proton-continuum, in effect concentrating the proton strength near the emission threshold. Additional experiments with the spectrograph established an upper limit of alpha-decay from the same resonance, confirming this interpretation. Another line of investigation addresses the mixing of unbound states through the continuum, studied in the spectrum of the first two $3/2^+$ resonances in $^{13}$N and $^{13}$C. Detailed experiments on the decay angular correlations were performed and used to characterize the angular momentum content of continuum interactions. We believe that a better understanding of the role of continuum on the spectrum of resonances is an important contribution to the physics of the most exotic nuclei.

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